National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID: DCA04IA002	Aircraft Registration Number: HB-IQZ
	Occurrence Date: 10/05/2003	Most Critical Injury: None
	Occurrence Type: Incident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone
Miami	FL		0000	EDT

Airport Proximity: Off Airport/Airstrip | Distance From Landing Facility:

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
Airbus Industrie	A330	Airplane

Revenue Sightseeing Flight: No | Air Medical Transport Flight: No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

HISTORY OF FLIGHT

On October 5, 2003, about 0155 eastern daylight time, an Edelweiss Airbus 330-243, HB-IQZ, experienced an engine fire and an uncontained engine failure of the No. 1 engine while climbing through flight level (FL) 230. The flight crew contacted Miami Center and requested clearance to return to Miami International Airport (MIA) Miami, Florida. The flight had departed MIA about 0145 on a regularly scheduled flight to Zurich, Switzerland, and was operating on an instrument flight rules flight plan under the provisions of 14 Code of Federal Regulations (CFR) Part 129. No injuries were reported for the 12 crewmembers and 171 passengers on board. Visual meteorological conditions prevailed at the time of the incident.

During interviews after the incident, the flight crewmembers reported that as they were climbing through FL 230, the master warning system annunciated along with a corresponding electronic centralized aircraft monitoring (ECAM) system message indicating turbine exhaust gas temperature overheat in the No. 1 engine. They reported that, shortly afterward, they felt heavy vibrations in the airplane and the No. 1 engine's fire warning system activated with a corresponding ECAM fire warning message. The pilots reported that they discharged one fire bottle into the nacelle but that the fire warning lights did not extinguish. They stated that a second fire bottle was discharged but that the fire warning lights remained illuminated. They indicated that an extra flight crewmember went back to the passenger cabin to see if he could inspect the engine from the passenger windows. The flight crewmember was unable to see any fire at that time but passengers reported that they had seen sparks, then white and orange flames.

The flight crew contacted Miami Center and requested clearance back to MIA. During the descent to MIA, at about 300 knots, the No. 1 engine fire warning lights extinguished. The pilot-flying requested a fire brigade to stand by for the landing, which the flight crew successfully performed with only the No. 2 engine operational. The fire brigade gave the go-ahead for the airplane to taxi up to gate E33. The flight crew had the airplane down safely on the ground within 20 minutes of the No. 1 engine failure. During the interviews held after the event, the pilot-flying stated that the air and ground traffic control communications were "great" and that the flight crew used crew resource management (CRM) effectively.

ENGINE INFORMATION

Both engines were Rolls-Royce Trent 772-60/16 turbofan engines and were installed on the airplane when it was delivered new from Airbus on November 21, 2000; neither engine had been removed or overhauled since they were installed. Both engines had accumulated 15,169 hours time since new (TSN) and 2,348 cycles since new (CSN).

The Rolls-Royce Trent 700 engine is a three-shaft, high-bypass-ratio, modular turbofan engine with

Narrative (Continued)

low pressure (LP), intermediate pressure (IP) and high pressure (HP) compressors driven respectively by LP, IP, and HP turbines through coaxial shafts. The LP system consists of a single-stage, wide-chord, hollow fan blade compressor driven by a four-stage turbine. The IP system consists of an eight-stage axial flow compressor driven by a single-stage turbine. The HP system consists of a six-stage axial flow compressor driven by a single-stage turbine. The combustion system is an annular construction incorporating fuel spray nozzles.

The initial on-scene examination of the No. 1 engine revealed that the IP turbine case exhibited a 360° circumferential rupture that created a gap between the IP and LP turbine cases. The IP turbine disk was still in place, but the disk rear drive arm was fractured circumferentially 360 degree around and all the blades were missing from the disk's blade slots. The HP/IP turbine bearing chamber external vent tube exhibited two burn-through holes located just outboard of the IP turbine case connection. The thrust reverser sustained damage to the inner and outer fixed structures. There was additional damage to the left wing and to the fuselage of the aircraft.

A borescope inspection of the No. 2 engine's HP/IP turbine bearing chamber external and internal vent tubes revealed the presence of black coke-like (black carbon deposits from the decomposition of oil under heat loads) buildup in the internal vent tube. The carbon obstruction largely filled the tube cross-section and was concentrated at the midpoint of the tube. The vent tube carries a mixture of air and oil droplets away from the bearing chamber.

Both engines were sent back to the Rolls-Royce facility in Derby, United Kingdom, for examination and teardown.

TEARDOWNS AND EXAMINATIONS

No. 1 Engine Teardown
Disassembly of the IP turbine nozzle guide vane support revealed that the only remaining part of the internal vent tube upper section was a small piece of the upper vent tube section with the IP turbine case connection fitting still attached, together with the outer heat shield . This small piece of the internal vent tube exhibited severe heat distress while the heat shield exhibited only minor pinholing damage. Apart from a short piece of the tube that remained attached to the HP/IP turbine bearing chamber, no portion of the internal vent tube lower section or its associated heat shield was recovered. The fracture surface of the vent tube lower piece appeared torn and exhibited moderate thermal damage.

Closer examination of the IP turbine disk drive arm fracture surfaces revealed heavy mechanical damage, smearing, and localized areas of a blue/black appearance. The drive arm was fractured in plane with the R850 cooling holes. The IP turbine disk was removed from the engine and was sent to the Rolls-Royce material laboratory for a detail metallurgical examination and dimensional inspection. Examination of the microstructure of the fracture surface through the R850 cooling holes in the disk drive arm revealed extensive oxidation and changes consistent with temperatures above 1000 degrees C (1832 degrees F). According to Rolls-Royce, the heat input into the drive arm was a combination of friction and fire.

No. 2 Engine Teardown
A borescope inspection of the entire HP/IP turbine bearing chamber and associated oil tubes revealed that the HP/IP turbine bearing chamber internal vent tube exit pocket¾part of the bearing chamber itself¾exhibited a considerable amount of soft granular carbon deposits at the outlet but that the pocket was not entirely blocked; however, extensive obstruction was noted approximately 2.25 inches outboard into the internal vent tube that prevented forward progress of the borescope.

An airflow check was performed on the blocked internal vent tube and revealed that air was able to pass through the carbon obstruction, indicating that the passage was not entirely blocked. Disassembly of the IP turbine nozzle guide vane support revealed that the HP/IP turbine bearing

Narrative (Continued)

chamber buffer air tubes were crack free; however, large parts of the heat shield for both the lower internal vent and scavenge tubes were missing. In both cases, the tubes exhibited some fretting damage but neither of the tubes was breached. According to Rolls?Royce, tube frettage at this inboard location is not uncommon but, at the time of the event, there had been no reports of a breached tube.

Carbon Examination
Between February and May 2004, three-dimensional (3-D) neutron tomography was used to determine the extent and morphology of the carbon deposit in the No. 2 engine's internal vent tube. The tomography showed only partial blockage of the tube with carbon deposits. On completion of the tomography, the vent tube was cut open lengthways for visual inspection and analysis of the carbon deposit. The visual examination confirmed the 3-D neutron tomography findings. Rolls-Royce concluded that the morphology, location and geometry of the deposits found in the vent tube of No 2 engine were different from those typically seen on other Trent engines. ExxonMobil also concluded that there was a significant difference in carbon formation in the internal vent tube of No 2 engine and that the geometry of the deposits was unusual relative to that seen in other Trent 700 engine operation.

Oil Samples and Analysis
Edelweiss reported that Mobil Jet Oil (MJO) II was originally used in the incident engines but that, after 2 months of service, the oil was switched to MJO 291. According to Rolls-Royce, Edelweiss was the only Trent 700 operator that used MJO 291 in its engines. Oil samples were taken from the No. 1 and No. 2 engines and from the oil in the flyaway kit that was onboard the incident airplane. Rolls-Royce, Exxon Mobil, and QinetiQ, an independent oil analysis laboratory located in Farnborough, United Kingdom, conducted oil analysis on the recovered samples. The results indicated that the oil in the No. 1 engine was exposed to elevated temperatures, that the oil samples from the No. 2 and the flyaway kit were typical of used and new MJO 291 oil respectively based upon the results of laboratory testing during the original evaluation of the oil for use in this engine, and that no significant evidence of oil contamination was noted in either the No. 1 or No. 2 engine.

Coking testing was conducted on the oil samples taken from both engines and new production MJO 291. The tests confirmed that MJO 291 conformed to industry standards and, although coking test results did vary from facility to facility, they were still within the established criteria for these types of test.

ADDITIONAL INFORMATION
Oil History
When the Trent 700 was introduced into service in the early 1990s, Rolls-Royce approved the following oils for use: AeroShell Turbine Oil (ASTO) 500, ASTO 555, ASTO 560, MJO II and MJO 254. On March 29, 1996, Rolls-Royce added MJO 291 and Exxon Turbo Oil 2197 as approved oils for the Trent 700 engines. Approval of the oil was based upon satisfactory performance in a 150 hour Development Engine Endurance Test in a Trent 700 engine in addition to Thermal Life Stability Calculations and a Laboratory Evaluation in accordance with CAA/JAA requirements. ExxonMobil stated in a letter dated December 10, 2004, that production had stopped on MJO 291 due to leaking seals in other engine models.

Previous Carbon Buildup Events
In May 1997, significant carbon buildup was found in the HP/IP turbine bearing chamber internal oil vent tube in two Trent 700 engines. Therefore, Rolls-Royce issued two non-modification service bulletins (NMSBs) that required on-wing inspections. The first NMSB introduced a repetitive borescope inspection for the HP/IP turbine bearing chamber internal oil vent tube and instructed vent tube cleaning if carbon accumulation was found. The second NMSB set the initial and repetitive inspection intervals at 1,500 hours. The data gathered from the repetitive inspections indicated that all Trent 700 engines inspected at up to 3,000 hours were free of carbon buildup;

Narrative (Continued)

therefore, the NMSB was revised to increase the inspection threshold and repetitive inspection interval to 3,000 hours. The data from both NMSBs indicated that adverse carbon accumulation was confined to operations using ASTO 560. Because of this, Rolls-Royce issued a service bulletin (SB) in 1999 that deleted ASTO 560 from the list of approved oils for the Trent 700 and 800 engines.

The repetitive on-wing inspections of Trent 700 and 800 engines continued; however, since the deletion of ASTO 560 from the list of approved oils, no significant buildup of carbon was found in engines over 10,000 hours. Therefore, Rolls-Royce, with the agreement of the United Kingdom Civil Aviation Authority (CAA), considered that the problem had been addressed and recognized the known potential for human error in breaking into the oil system, and its particular significance for twin engine-aircraft maintenance, recommended canceling the on-wing inspection based on evidence that the service problem was related to the use of ASTO 560. The United Kingdom Civil Aviation Authority (CAA) cancelled the SB on March 29, 2000. The NMSB was cancelled before the incident engine went into service; therefore, neither the incident engine nor its sister engine vent tubes were ever subjected to an on-wing inspection.

Postincident Service Bulletins and Airworthiness Directives
Following the Edelweiss incident, Rolls-Royce issued an alert service bulletin (ASB) on December 3, 2003, that recommended a one-time on-wing inspection of the HP/IP turbine bearing chamber vent tube and recommended that operators report back the findings. The on-wing inspection can only detect tube obstruction, not damage or failure of the heat shield. On December 18, 2003, the United Kingdom CAA issued an airworthiness directive (AD) mandating the ASB. The AD also required reporting the findings of the internal vent tube inspection to Roll-Royce. Based on the one-time inspection results, Rolls-Royce revised the ASB to include recurrent inspections of the HP/IP turbine bearing chamber vent tube regardless of the oil type used by the operator. The CAA followed with an AD to mandate the recurrent inspections.

At the time of the investigation, fleet checks of 179 high-cycle Trent 700 engines revealed various amounts of coke formation, but no operator reported a coke formation similar to that of the incident's sister engine. Three of the engines inspected had about 75 percent blockage of the vent tube and were cleaned on-wing. Inspections for the internal vent tube upper and lower heat shields were performed when the engines came in for overhaul. Seventy engines were inspected for heat shield damage. Fifty percent of the vent tube lower heat shields in these engines were found cracked, torn, or missing, and about 30 to 50 percent of the vent tube upper heat shields were found cracked. Only one of the 70 vent tube upper heat shields inspected was found with advanced damage.

Overhaul Manual Changes
Rolls-Royce has issued several overhaul manual changes that incorporate borescope inspections, inspections for heat shield damage, and cleaning the IP turbine vent tube. Rolls-Royce requested that overhaul bases return damaged or obstructed oil service tubes to Royce-Royce Derby for examination and evaluation.

Qualification/Approval of Oils
During this investigation, it was revealed that the science of qualifying oils for newer, higher performance engines may not duplicate the actual operating environment that the oil will be exposed to and that further tests should be considered in the light of in-service experience. The main international forum for evaluating new and improved test methods for inclusion into the civil gas turbine lubricant specification, AS 5780, is via the industry led SAE E34 Propulsion Lubricants Committee. The Committee comprises expertise from all major OEM's, Military and Government agencies (including Civil Airworthiness Authority input) as well as specialists from independent test facilities and lubricant suppliers, thus ensuring the adoption of industry best practices within such specifications. The AS5780 specification has incorporated all OEM coking test methods with defined performance limits for Qualification and Production Quality Control. Moreover, SAE E34, as an industry forum, is continuously improving such specifications by due process, on the basis of

Narrative (Continued)

in-service experience and new test method developments.

Operating Environment
The incident airplane was on an extended twin-engine operation (ETOPS) route at the time of the event. The International Civil Aviation Organization defines ETOPS as any flight by an aeroplane with two turbine power units where the flight time at the one power-unit inoperative cruise speed, from a point on the route to an adequate alternate aerodrome is greater than the threshold time approved by the state of the operator. An operator has to be approved to operate ETOPS routes and has to meet special maintenance requirements that exceed those required for non-ETOPS operators. The mandatory engine monitoring requirements were in place at Edelweiss, and the operator was found to be ETOPS-compliant. The engines on the incident aircraft did not give any indication of high oil consumption before the initiating event. None of the engine parameters that were being monitored or the inspections that were in place detected the carbon buildup in the internal vent tube.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID: DCA04IA002
	Occurrence Date: 10/05/2003
	Occurrence Type: Incident

Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
	MIA	Ft. MSL			

Runway Surface Type:

Runway Surface Condition:

Approach/Arrival Flown:

VFR Approach/Landing:

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
Airbus Industrie	A330	

Airworthiness Certificate(s): Transport

Landing Gear Type: Retractable - Tricycle

Amateur Built Acft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No		LBS	2

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Fan	Rolls-Royce	Trent 700	71100 LBS

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
		Hours	Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed?/Type	ELT Operated?	ELT Aided in Locating Accident Site?

Owner/Operator Information

	Street Address		
Registered Aircraft Owner			
	City	State	Zip Code
Operator of Aircraft	Street Address: 1211 Avenue of the Americas		
Edelweiss Air AG	City: New York	State: NY	Zip Code: 10036

Operator Does Business As:	Operator Designator Code:

- Type of U.S. Certificate(s) Held:

Air Carrier Operating Certificate(s): Foreign Operation

Operating Certificate:	Operator Certificate:

Regulation Flight Conducted Under: Non-U.S., Commercial

Type of Flight Operation Conducted: Scheduled; International; Passenger Only

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID: DCA04IA002

Occurrence Date: 10/05/2003

Occurrence Type: Incident

First Pilot Information

Name	City	State	Date of Birth	Age
On File				

Sex: | Seat Occupied: | Occupational Pilot? | Certificate Number: On File

Certificate(s):

Airplane Rating(s):

Rotorcraft/Glider/LTA:

Instrument Rating(s):

Instructor Rating(s):

Current Biennial Flight Review?

Medical Cert.: | Medical Cert. Status: | Date of Last Medical Exam:

- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time										
Pilot In Command(PIC)										
Instructor										
Instruction Received										
Last 90 Days										
Last 30 Days										
Last 24 Hours										

Seatbelt Used? | Shoulder Harness Used? | Toxicology Performed? | Second Pilot?

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point	State	Airport Identifier	Departure Time	Time Zone
Maimi	FL	MIA	0000	EDT

Destination	State	Airport Identifier
Zurich		

Type of Clearance:

Type of Airspace:

Weather Information

Source of Wx Information:

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID:	DCA04IA002
Occurrence Date:	10/05/2003
Occurrence Type:	Incident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
			Ft. MSL	NM	Deg. Mag.

Sky/Lowest Cloud Condition: Ft. AGL	Condition of Light:
Lowest Ceiling: Ft. AGL	Visibility: SM
Altimeter: "Hg	
Temperature: °C	Dew Point: °C
Weather Conditions at Accident Site: Visual Conditions	
Wind Direction: 280	Wind Speed: 15
Wind Gusts:	
Visibility (RVR): Ft.	Visibility (RVV) SM

Precip and/or Obscuration:

Accident Information

Aircraft Damage:	Aircraft Fire:	Aircraft Explosion
Minor	In-flight	None

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants				9	9
Other Crew				1	1
Passengers				171	171
- TOTAL ABOARD -				183	183
Other Ground					
- GRAND TOTAL -				183	183

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID:	DCA04IA002
Occurrence Date:	10/05/2003
Occurrence Type:	Incident

Administrative Information

Investigator-In-Charge (IIC)

Effie L. Ward

Additional Persons Participating in This Accident/Incident Investigation:

TR Proven